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ROCKY MOUNTAIN FOREST AND RANGE EXPERIMENT STATION

The Independence of the Point-to-Point Variations in Windspeed and Temperature in a Lodgepole Pine Stand

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The carrelatian between lacal variatians in air temperature and windspeed at particular levels in a pine stand are examined far evidence af persistent mamentum transpart by thermal canvectian. The results argue against such an effect; the paint-to-paint deviatians appear ta be independent.

Oxford: 111.84;111.2;111.5;907.3;U536.2. Keywords: Forest metearalagy, canvectian, micrometearalagy, air temperature, wind, *Pinus contorta*.

Recent measurements of windspeed and temperature profiles in an even-aged lodgepole pine stand indicated large point-to-point differences for both variables measured between trees at the same height and time.[2] [3] These differences appeared to be random, with no trend along either the downwind or crosswind direction. Such variation raised the question as to whether the subcanopy flow consists of a network of local density flows in response to the horizontal pressure gradients generated by the temperature field, rather than the large-scale pressure gradient.

If subcanopy thermal circulations were this pronounced, we would expect a strong negative correlation throughout the live crown between windspeed and temperature. Locations where air temperatures were lower than average would be regions of descending currents, bringing high-speed air from above the canopy. In contrast, the "warm spots" would be regions of ascent, with low-speed air moving into the above-canopy flow. On the other hand, if cool spots in the stand were associated with higher-than-average drag, the regions of strong downward momentum flux would also have offsetting above-average drag. The temperature does not appear to have any significant correlation with the local canopy cover for these locations, however,[4] and the canopy cover is generally conceded to be a relatively good index of local foliage density.

The temperature profiles were measured at noon on clear days with shielded bead thermistors at each of 6 levels at 17 locations. Windspeed profiles were measured during clear weather at the same heights. Details of the measurements may be found in two previous papers; [2] [3] full data on the physical structure of the stand appears in a paper by Gary.[5]

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[2] *Bergen, James D. 1971. Vertical profiles of windspeed in a pine stand. For. Sci. 17:314-321.*

[3] *Bergen, James D. Vertical air-temperature profiles in a pine stand: Spatial variation and scaling problems. (In press, For. Sci.)*

[4] *Bergen, James D. Variation of air temperature and canopy closure in a lodgepole pine stand. USDA For. Serv. Res. Note RM-253, 3 p. Rocky Mt. For. and Range Exp. Stn., Fort Collins, Colo.*

[5] *Gary, H. L. Crown structure and vertical distribution of biomass in a lodgepole pine stand. (Manuscript in preparation at the Rocky Mt. For. and Range Exp. Stn., Fort Collins, Colo.)*

In the calculation to follow, the noon temperature profiles have been scaled by the temperature drop above the canopy; that is,

$$T' = \frac{T - T_h}{T_a - T_b}$$

where T_h is the temperature at the 22-m height and T_a the temperature at 11.5 m on a fixed tower within 30 m of the points of measurement. This scaling is examined in detail in a previous paper.[3] The windspeed (U) has been scaled by the friction velocity (U_*) above the canopy as estimated from windspeeds on the reference tower.[2] Windspeed and temperature measurements were restricted to times when the flow was southwesterly above the canopy. The profiles of the scaled speed were found to be relatively independent of U_* and of the Richardson's number at the reference tower.

Compatible wind and temperature profiles were available for 17 points (fig. 1). Linear correlations were computed over these points for the average scaled temperatures (T') and speeds (U/U_*) in the subcanopy, the lower canopy, and the upper canopy. These averages were computed for the consecutive pairs of measurements at the 1, 2.5, 4.0, 5.6, 7.0, and 8.5-m levels for the airspeed and temperature averages, and are shown in table 1.

Table 1.--Correlation matrix, temperature, and scaled windspeed

Canopy level	Sub-canopy	Middle canopy	Upper canopy
Subcanopy:			
Windspeed	1.00	0.65	0.81
Temperature	1.00	.77	.59
Windspeed vs. temperature	- .10	- .05	- .21
Middle canopy:			
Windspeed		1.00	.38
Temperature		1.00	.45
Windspeed vs. temperature		- .10	- .34
Upper canopy:			
Windspeed			1.00
Temperature			1.00
Windspeed vs. temperature			.37

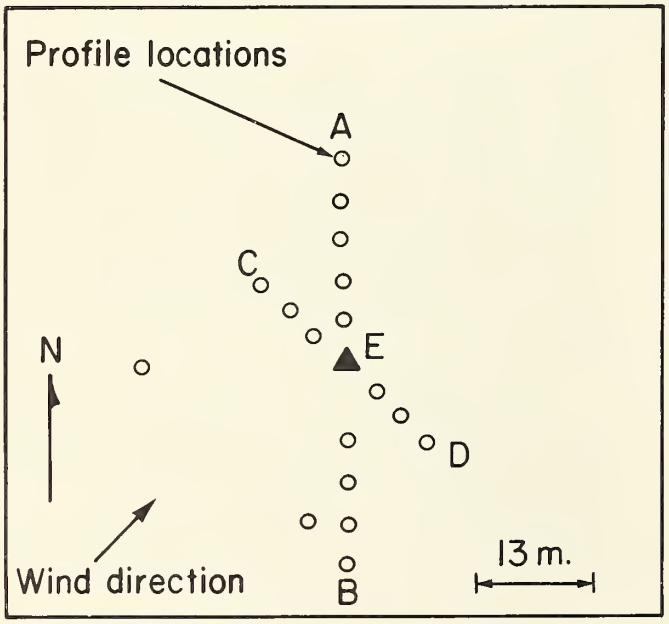

Figure 1.—Location of temperature-windspeed profiles.

As may be seen, there is no substantial negative correlation between temperature and windspeed at any level. In fact, the wind and temperature profiles show relatively little coherence as judged from the second and third columns of the table.

To the extent that the horizontal temperature differences and the average temperatures computed for the locations of figure 1 are representative of the local stand temperature field, the local pressure distribution must be determined by either the synoptic gradient or the flow above the canopy. In particular, there appears to be no appreciable transport of momentum into the canopy by large-scale thermal currents.

The apparent independence of the wind and temperature fields would also tend to support the use of stand averages of temperature and windspeed when using energy balance techniques to estimate evaporation at the forest floor.

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